

NASA's New Worlds News

The EXOPLANET EXPLORATION PROGRAM Newsletter



Issue 15 - May 2015

Please visit <http://exep.jpl.nasa.gov/newslettersarchive-htmlfiles/2015May.html>
to view the HTML version of this newsletter.

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Do you have an accomplishment or event you want to share in Community Highlights? Send it to us at nasaexoplanetnews@jpl.nasa.gov. Please limit your submissions to no more than 150 words.



New Name for Institute for Pale Blue Dots

Cornell's Institute for Pale Blue Dots has officially been renamed the Carl Sagan Institute: Pale Blue Dot and Beyond.

1. Message from NASA Astrophysics Division Director



By Paul Hertz, Director, NASA Astrophysics Division

The enduring science questions for astrophysics--how does the universe work, how did the familiar sky of galaxies and stars come to be, are we alone--form the foundation of the strategic science drivers behind the past five decadal survey documents provided by the National Academy of Sciences, including the 2010

Decadal Survey, New Worlds, New Horizons in Astronomy and Astrophysics. As I described during the NASA Town Hall at the 225th meeting of the American Astronomical Society (AAS) in Seattle, Wash., NASA is making progress toward these goals in 2015.

- In 2014, NASA Astrophysics flight missions continued to be highly productive, announcing ground-breaking discoveries every month.
- The FY15 Appropriations Act provides funding for NASA astrophysics sufficient to continue its programs, missions, and projects as planned. The total funding appropriated for NASA astrophysics, including James Webb Space Telescope (JWST), is \$1.33B, the same as appropriated in FY14. This appropriation fully funds JWST to remain on plan for an October 2018 launch; funds continued preformulation and technology work leading toward Wide-Field Infrared Survey Telescope (WFIRST); restores the Stratospheric Observatory for Infrared Astronomy (SOFIA) to the budget albeit with a 17% reduction from FY14; provides funding for the Science Mission Directorate's education programs; and funds NASA's core astrophysics research, technology, Explorers, and operating mission programs.
- The astrophysics operating missions continue to generate important and compelling science results, and new missions are under development for the future. Chandra, Fermi, Hubble, Kepler-K2, Nuclear Spectroscopic Telescope Array (NuSTAR), Spitzer, Suzaku, Swift, and

PLANET COUNT

updated May 27, 2015



For information on any of the stories or events below, please visit:

<http://exep.jpl.nasa.gov/newslettersarchivelist/>

EXOPLANETS IN THE NEWS

April 21, 2015

NASA's NExSS Coalition to Lead Search for Life on Distant Worlds

April 15, 2015

Glitter Cloud May Serve As Space Mirror

April 14, 2015

NASA's Spitzer Spots Planet Deep Within Our Galaxy

April 7, 2015

The Solar System and Beyond is Awash in Water

April 6, 2015

NASA Selects 2015 Carl Sagan Fellows

March 23, 2015

Kepler Wins National Air and Space Museum Trophy

March 4, 2015

Planet 'Reared' by Four Parent Stars

January 28, 2015

Astronomers Discover Ancient System with Five Small Planets

January 20, 2015

Telescope To Seek Dust Where Other Earths May Lie

XMM-Newton have been awarded mission extensions following the 2014 Senior Review.

SOFIA is in prime operations as of May 2014. Missions under development (and their currently planned launch dates) include the International Space Station-Cosmic Ray Energetics and Mass (ISS-CREAM) experiment (2015), Laser Interferometer Space Antenna (LISA) Pathfinder (2015), ASTRO-H (2015), the Neutron Star Interior Composition Explorer (NICER) mission (2016), the Transiting Exoplanet Survey Satellite (TESS, 2017), JWST (2018), and Euclid (2020). New Explorers will be selected (SMEX in 2015, MIDEX in 2017), and NASA is joining ESA's Athena mission and ESA's L3 gravitational wave observatory.

- JWST continues to make progress, having completed a highly successful cryovacuum test of the Integrated Science Instrument Module in 2014. The start of the primary mirror assembly is scheduled for 2015, amongst other major milestones. JWST remains on cost and on schedule for an October 2018 launch.
- The Hubble Space Telescope 25th Anniversary on April 24, 2015, was celebrated through a series of events including social and traditional media outreach programs; exhibits around the world at museums, airports, and other venues; education programs in all 50 states; re-release of the IMAX "Hubble 3D" movie; and many more activities to engage the public, students, and educators worldwide; see <http://hubble25th.org/> for details.
- The preformulation study of WFIRST continues in 2015 with the \$50M appropriated for the purpose. In early 2015, the Science Definition Team submitted its report to NASA; it is available at <http://wfirst.gsfc.nasa.gov/>. The rest of the year will include technology development for the instruments and continued risk mitigation activities for the telescope and the mission.
- NASA and the National Science Foundation (NSF) have initiated a partnership for exoplanet research in response to the 2010 Decadal Survey recommendation to "...support an aggressive program of ground-based high-precision radial velocity surveys of nearby stars to identify potential candidates ... for a future space imaging and spectroscopy mission." Initially, the National Optical Astronomy Observatory (NOAO) share of the WIYN telescope will be made available to the U.S. astronomical community using the existing instrumentation for an exoplanet-targeted guest observer program. A NASA-funded facility-class Extreme Precision Doppler Spectrometer for the WIYN telescope will be made available when it is completed around 2018; NASA has solicited proposals for instrument development through Research Opportunities in Space and Earth Sciences (ROSES).
- An Announcement of Opportunity for the Astrophysics Explorers Program was released in September 2014, and approximately 25 proposals were received before the December 18, 2014, due date. The target for Step 1 selections is summer 2015 (for additional information, see <http://explorers.larc.nasa.gov/APSMEX/>).
- The Astrophysics Research Program had a proposal selection rate of between 11% and 56% for ROSES R&A competitions in 2014, with an overall average proposal selection rate of ~20% across all of astrophysics; the details are available in my Town Hall presentation. There will be no solicitation for proposals for the Astrophysics Theory Program (ATP) in 2015; there is no loss in ATP funding, just resynching the solicitation schedule with the availability of funding to reduce the long waiting period for the distribution of funds.
- Progress continues to be made towards achieving 2010 Decadal Survey priorities through strategic technology development and partnerships, as described in earlier newsletters. A "scoreboard" of progress against Decadal Survey prioritized recommendations is available in my Town Hall presentation.
- The Astrophysics Mid-Decade Review will be conducted during 2015-2016. The study will be co-sponsored by NASA, NSF, and DOE, which have charged the National Research Council. The formation of the Study Committee is underway.
- A major activity for the Astrophysics Division this year is beginning preparation for the 2020 Decadal Survey. To enable prioritization of large space mission concepts to follow JWST and WFIRST by the 2020 Decadal Survey Committee, NASA needs to conduct mission concept studies and initiate technology development for candidate large space missions. NASA's plans are described in "Planning for the 2020 Decadal Survey: An Astrophysics Division White Paper," available at <http://science.nasa.gov/astrophysics/documents/>.

My entire Town Hall presentation from the January AAS meeting, as well as the 2014 "Update to the Astrophysics Implementation Plan," is available at <http://science.nasa.gov/astrophysics/documents/>.

2. Program Manager's Update

January 6, 2015

NASA's Kepler Marks 1,000th Exoplanet Discovery, Uncovers More Small Worlds in Habitable Zones

December 18, 2014

NASA's Kepler Reborn, Makes First Exoplanet Find of New Mission

December 2, 2014

Stardust Not Likely to Block Planet Portraits

November 10, 2014

Follow the Dust to Find Planets

EVENTS

ExoPAG 12

June 13-14

Location: Chicago, Illinois

Astrobiology Science Conference 2015 (AbSciCon2015):

Habitability, Habitable Worlds, and Life

June 15-19

Location: Chicago, Illinois

In the spirit of Bernard Lyot 2015: Direct Detection of Exoplanets and Circumstellar Disks

June 22-26

Location: Montreal, Canada

Extreme Precision Radial Velocities

July 5-8

Location: New Haven, Connecticut

2015 Sagan Exoplanet Summer Workshop - Exoplanetary System Demographics

July 27-31

Location: Pasadena, California

XXIX IAU General Assembly August 3-14

Location: Honolulu, Hawaii

ExoStats: Exoplanets and Statistics - IAU General Assembly XXIX Focus Meeting 8

August 3-5

Location: Honolulu, Hawaii

SPIE Optics + Photonics 2015 August 9-13



By Gary Blackwood, Manager, Exoplanet Exploration Program Office

In 1995, astronomers started a revolution.

It took humans thousands of years to find the seven other planets in our solar system, and, not long ago, it seemed possible that was the limit of what we'd discover. Exoplanets--worlds orbiting stars beyond our own--were thought to be so distant, so tiny, and so hard to find that we'd never find them, even if they did exist.

Then, everything changed. Two astronomers, Michel Mayor and Didier Queloz, found a gas giant planet orbiting strangely close to the star 51 Pegasi. It was the first time a planet had been found orbiting another Sun-like star (the only previous exoplanet discovery had been around a dead star called a pulsar). Within just a few days, the discovery was confirmed by Geoffrey Marcy and Paul Butler. The race to find these so-called "exoplanets" was on, and practically every new discovery from then on overturned old assumptions about how the galaxy works and teased tantalizing new possibilities.

Today, 20 years later, exoplanets have become one of the most exciting and important topics in astronomy today. The Exoplanet Exploration Program is part of a growing movement toward exoplanet discovery, characterization, and the search for habitable worlds--and the search for life on these new worlds. Projects within the Program such as Kepler and the Large Binocular Telescope Interferometer are refining our knowledge of planetary occurrence rates and the prevalence of exozodiacal dust. A new NASA-NSF initiative, the Extreme Precision Doppler Spectrometer on Kitt Peak's WIYN telescope, will perform follow-up measurements for Kepler and K2 discoveries and will perform precursor science for James Webb Space Telescope (JWST) transit spectroscopy and for Wide-Field Infrared Survey (WFIRST) direct imaging. The Astrophysics Division Director has charged the Program Analysis Groups (PAGs) to recommend large-scale missions to study in preparation for the 2020 Astrophysics Decadal Survey, and at least two of the concepts emphasize direct imaging of habitable exoplanets and the detection of biosignatures.

NASA is developing plans to celebrate the past 20 years of exoplanet exploration, and to imagine what the next 20 years will bring, through events and an online communications campaign. You can keep track of all public activities by visiting: <http://planetquest.jpl.nasa.gov/>. We hope to join the entire exoplanet community in celebrating this truly amazing milestone.

What began with the single discovery of an incredibly hot, strange planet orbiting another star has now brought us to the cusp of answering ancient questions about our place in the galaxy and whether or not other worlds like ours exist. Twenty years ago, exoplanets, especially Earth-like ones, were the stuff of science fiction. Today, and thousands of discoveries later, astronomers are on the cusp of finding something people have dreamed about for thousands of years--another Earth.

Written with contributions from Josh Rodriguez

3. NASA Selects 2015 Carl Sagan Fellows



Excerpted from [April 6th press release](#)

By Whitney Clavin, NASA Jet Propulsion Laboratory Media Representative

NASA has selected six scientists as recipients of the 2015 Carl Sagan Exoplanet Postdoctoral Fellowships.

Significant discoveries and advances have already been made by previous Sagan Fellows. Recent science results from the fellows include the most precise measurement ever of the radius of a planet outside our solar system, and images of exoplanets obtained with an Earth-based telescope using the same type of imaging sensor found in digital cameras.

The 2015 Sagan Fellows are:

- Courtney Dressing, who will work at the California Institute of Technology in Pasadena on "Characterizing Small Planets Orbiting Small Stars." Dressing will use data from NASA's Kepler space telescope and its follow-on mission, K2, to distinguish false positive planet candidates and to characterize red dwarfs hosting small planets. She will also measure the mass of small planets to further characterize their compositional properties and investigate the

Location: San Diego, California

SPIE Optics + Photonics 2015
August 9-13

Location: San Diego, California

Space Studies Board (SSB)
(National Academy of Sciences)
November 3-4

Location: Irvine, California

47th Annual Division for Planetary Sciences Meeting
November 8-13

Location: National Harbor, Maryland

Extreme Solar Systems III
November 29 - December 4

Location: Waikoloa Beach, Hawaii

PROGRAM WEBSITES

Exoplanet Exploration Program (ExEP)

<http://exep.jpl.nasa.gov/>

PlanetQuest - Public Outreach Website

<http://planetquest.jpl.nasa.gov/>

NASA Exoplanet Science Institute (NExSci)

<http://nexsci.caltech.edu/>

NASA Science Astrophysics

<http://science.nasa.gov/astrophysics/>

NASA Cosmic Origins Program (COR)

<http://cor.gsfc.nasa.gov/>

NASA Physics of the Cosmos Program (PCOS)

<http://science.nasa.gov/astrophysics/>

link between stellar hosts and planetary properties.

- Daniel Foreman-Mackey, who will work at the University of Washington in Seattle on "Flexible and Robust Inference of the Exoplanet Population." Foreman-Mackey will use statistical methods to examine the large catalog of exoplanet discoveries, studying their distribution as a function of their physical parameters. He plans to derive a common framework for robust population inference and to apply this method to existing and forthcoming catalogs of exoplanet data.
- Jonathan Gagne, who will work at the Carnegie Institute for Science in Washington on "Locating the Young, Isolated Planetary-Mass Objects in the Solar Neighborhood." Gagne will use ground-based observations to explore the connection between the atmospheres of brown dwarfs and those of giant exoplanets. This will constrain the initial mass function down to a few times the mass of Jupiter, hence testing the recent prediction that the spatial density of isolated Jupiter-mass objects is twice as large as that of stars.
- Paul Robertson, who will work at Pennsylvania State University in State College on "Spotting Blue Planets Around Spotted Red Stars: Removing Stellar Activity from Radial Velocities of M Dwarf Stars." Robertson plans to develop a generalized method for disentangling stellar activity from radial velocity (RV) measurements of M stars in near-infrared wavelengths. He will develop a multi-dimensional modeling package that simultaneously models planet signals and activity-RV correlations, rather than separating analyses of the two. This will lead to robust detections of low-mass planets in the habitable zone.
- Ty Robinson, who will work at the University of California in Santa Cruz on "Bridging the Theory Gap: Developing a Novel Cloud Model for Exoplanets." Robinson is interested in understanding cloud dynamics which are key to characterizing and modeling exoplanets. Clouds strongly influence many exoplanet observations, and Robinson will work toward developing new and efficient cloud models that lead to better interpretation of exoplanet observations.
- Leslie Rogers, who will work at the University of California in Berkeley on "Searching for Water in Distant Worlds." Rogers will use three approaches, atmospheric transmission spectra, exoplanet radio aurora emissions, and the accumulating statistical ensemble of planet mass-radius, to constrain the bulk water content of distant exoplanets. These data will be used to evaluate planet formation theories for the abundance of Neptune-sized exoplanets.

For more information about the recipients, visit:

<http://nexsci.caltech.edu/sagan/2015postdocRecipients.shtml>

4. Probe Study Final Reports Released



*By Keith Warfield, NASA Jet Propulsion Laboratory
Probe Study Office Manager*

After a year and a half, the direct imaging probe studies have been completed and their results publicly released in two final reports. In 2013, NASA commissioned two Science and Technology Definition Teams (STDTs) to examine the feasibility of developing exoplanet direct imaging missions with compelling science, ready to start in 2017, and targeted at \$1B. One STDT--chaired by Karl Stapelfeldt (GSFC)--addressed a space telescope with a coronagraph design (Exo-C), while the other STDT--led by Sara Seager (MIT)--examined the starshade mission concept (Exo-S). Engineering support for the studies was provided by JPL. Both teams successfully met their objectives.

The coronagraph team developed a concept using a 1.4-meter off-axis telescope and a single science instrument consisting of a coronagraph with an integral field spectrograph (IFS) for spectral measurements. To contain costs, the concept borrows many design features from the successful Kepler mission. The mission operates for three years (with fuel for five years) in an Earth-trailing heliocentric orbit, and can image as close as 160 milliarcseconds to the target star. With a three-year mission, Exo-C can search 150 nearby stars for previously undetected planets (including 15 stars where super-Earth-size planets are detectable), image around 200 circumstellar disks, and measure spectra of 20 newly detected and previously identified planets. Use of Kepler heritage systems wherever possible and prior ExEP investments in coronagraph technology enable the mission to meet the FY17 project start date. The mission is also expected meet the \$1B cost target.

The starshade STDT developed two concepts for the study: a stand-alone mission including both the starshade and telescope spacecraft in a shared launch (referred to as the "Dedicated" option), and a

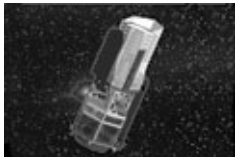
starshade-only concept with a starshade that launches independently to work with an existing space telescope (referred to as the "Rendezvous" option). The starshade Dedicated mission uses a commercial 1.1-meter on-axis telescope and a 30-meter starshade, each carried by commercially available spacecraft. The two spacecraft are co-launched into a heliocentric, Earth-leading, drift-away orbit and will operate for three years (with fuel for five years). The starshade Rendezvous mission adopted the Wide-Field Infrared Survey-Astrophysics Focused Telescope Assets (WFIRST-AFTA) space telescope for study and assumes WFIRST-AFTA is in orbit around the Earth-Sun L2 Lagrange point and is carrying a transponder for formation flying. The starshade Rendezvous mission joins up with the telescope sometime after the telescope has begun its primary science mission. Exoplanet science can be conducted with either a purpose-built direct imaging camera/IFS instrument, or--depending on the telescope's sensor payload--with existing imaging and spectroscopy instruments. Both options can image to within 100 milliarcseconds of the target star, enabling detections down to Earth-size planets in the habitable zone. Spectral characterization of Earths is possible with the Rendezvous mission option, reaching R=70 for the most favorable candidates. The Dedicated option is close to--but above--the \$1B target, while the Rendezvous option easily meets the cost goal.

The final reports provide valuable direct imaging mission design and technology development information and will likely feed into many of the concepts going into the next Astrophysics Decadal Survey. The reports can be downloaded for the ExEP website.

The Exo-C report is available in pdf format at URL: https://exep.jpl.nasa.gov/stdt/Exo-C_Final_Report_for_Unlimited_Release_150323.pdf

The Exo-S report is available in pdf format at URL: https://exep.jpl.nasa.gov/stdt/Exo-S_Starshade_Probe_Class_Final_Report_150312_URS250118.pdf

5. WFIRST-AFTA 2015 SDT Report Released



*By Ingolf Heinrichsen, NASA Jet Propulsion Laboratory
Program Office Mission Manager*

The Wide-Field Infrared Survey Telescope-Astrophysics Focused Telescope Assets (WFIRST-AFTA) Science Definition Team (SDT) was selected and chartered by the NASA Astrophysics Division in July 2013 to develop the AFTA Design Reference Mission. Under the leadership of David Spergel and Neil Gehrels, the team--consisting of Charles Baltay, Dave Bennett, James Breckinridge, Megan Donahue, Alan Dressler, Scott Gaudi, Tom Greene, Olivier Guyon, Chris Hirata, Jason Kalirai, Jeremy Kasdin, Bruce Macintosh, Warren Moos, Saul Perlmutter, Marc Postman, Bernie Rauscher, Jason Rhodes, Yun Wang, and David Weinberg--worked together with the WFIRST Study Team over the last two years to develop their 2015 Final Report, which has recently been released to the public. It is the result of an in-depth study into how the transfer of the 2.4-meter AFTA to NASA will enable a truly compelling version of the WFIRST, the top-priority space mission identified in the 2010 National Academy of Sciences' decadal survey, New Worlds, New Horizons in Astronomy and Astrophysics, and the maturation of exoplanet direct imaging technology and exoplanet precursor science.

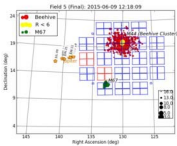
The 2015 SDT report summarizes the WFIRST-AFTA science program, presents a design reference mission, overviews the mission concept, describes recent progress in advancing the technical readiness of the key components, and shows how WFIRST-AFTA complements other planned ground-based and space-based telescopes to create an observing system for the 2020s that will transform our understanding of the universe.

The SDT's tenure will shortly come to an end as NASA lays the groundwork for WFIRST's expected future transition into the formulation phase, and the formation of a new science team. It has been a truly amazing experience to witness this group of extraordinary scientists lay the scientific groundwork for a mission that has the potential to alter our understanding of cosmology and exoplanet science in the next decade.

The report is available for download in pdf format from this URL: http://exep.jpl.nasa.gov/wfirst-afta/WFIRST-AFTA_SDT_Report_150310_Final.pdf

Also available: the WFIRST-AFTA SDT Final Report Briefing to Paul Hertz (PDF):
http://exep.jpl.nasa.gov/wfirst-afta/WFIRST-AFTA_SDT_Report_Briefing_to_Hertz_150219_Final_RevA.pdf

6. Kepler-K2 Update



Excerpted from [Mission Manager Update](#)

By Charlie Sobeck, NASA Ames Research Center
K2 Mission Manager

It was nearly a year ago that the Kepler spacecraft made a comeback after a technical setback: the loss of its ultra precise pointing capability. Revived as the K2 mission, now in its fifth observing campaign, the spacecraft continues

to operate beautifully.

K2 began Campaign 5 on April 26. The observation targets include more than 25,000 stars, which can be searched for exoplanets and examined for a variety of astrophysical phenomena. The field of study also includes M67, an open cluster home to thousands of stars younger than our sun and 2002 YH140, a dwarf planet orbiting beyond Neptune. The field is in the direction of the constellation Cancer.

Data collected for Campaigns 0, 1 and 2 have been made available to the public through the Mikulski Archive for Space Telescopes (MAST). Campaign 3 data are scheduled for delivery to MAST in June 2015 and Campaign 4 data will be processed with a delivery to MAST planned for August 2015.

During Campaign 3, observations of Neptune and two of its moons were conducted. Lead researcher, Jason Rowe, SETI Institute Kepler scientist at NASA's Ames Research Center at Moffett Field, California, stitched together more than 100,000 images to generate a movie of the Neptunian system. The movie illustrates 70 days of uninterrupted observation making this one of the longest continuous studies of an outer solar system object.

Last week, the team hosted a workshop for the microlensing science community to discuss observing strategies for K2's Campaign 9. Planned for April 2016, Campaign 9 will be the first time that a NASA spacecraft will undertake a large-area microlensing survey. Microlensing is a technique that can be used to detect long-orbital period planets, equivalent to our solar system planets like Jupiter and further out Neptune, around distant stars.

This K2 microlensing campaign will provide a unique opportunity to test an observing strategy and will contribute to NASA's ongoing study of a possible future Wide-Field Infrared Survey Telescope (WFIRST) mission, notionally planned to launch in the following decade. The K2 microlensing campaign will:

1. Facilitate community-based microlensing science
2. Enable development of tools for analyzing survey data
3. Inform planning for the execution of a WFIRST microlensing survey

To learn more about the K2 mission visit the Kepler Science Center website here:

<http://keplerscience.arc.nasa.gov/K2/>.

Tuesday, the Kepler spacecraft marked six years since it began its staring contest with the stars in search of other worlds. Lucky for us, the stars blinked first and often. So often in fact, that today we know of thousands of planets orbiting other stars than that of our backyard sun. Eight of these worlds may in some way be like Earth! For a look at more of the spacecraft's story, check out Kepler's Six Years in Science (and Counting) infographic here: <http://www.nasa.gov/ames/kepler/six-years-in-science>. For the latest Kepler exoplanet and candidate statistics, visit the NASA Exoplanet Archive.

Last week at a ceremony in San Jose, California, the Silicon Valley Business Journal honored Kepler mission co-investigator, Edna DeVore, in their 2015 Women of Influence. DeVore, director of education and outreach and acting CEO of the SETI Institute, has been a longtime member of the Kepler team responsible for establishing the mission's education and public outreach plan. As an astronomy educator since 1972, DeVore's leadership and teaching acumen has resulted in the development of planetarium programs, curricula for elementary, middle and high school students, and educational information that has reached teachers and students across the US and abroad. The Kepler and K2 education program materials can be found online here: <http://www.nasa.gov/kepler/education>.

The following are highlights of recent research using Kepler and K2 data that have been accepted for publication in a peer-reviewed journal:

- The Five Planets In The Kepler-296 Binary System All Orbit The Primary: A Statistical And Analytical Analysis (Barclay et al, 2015) - Kepler-296 is a binary star system with five small transiting exoplanets. This paper demonstrates that the planets all orbit the brighter star in the binary through follow-up observations and statistical modeling. This new analysis shows that two of these planets are smaller than twice the size of Earth and fall into the star's habitable zone. (Read more here: <http://arxiv.org/abs/1505.01845>.)
- Eccentricity from transit photometry: small planets in Kepler multi-planet systems have low eccentricities (Van Eylen et al, 2015) - Researchers based at Aarhus University in Denmark measured the orbital eccentricity of 74 small exoplanets and found their orbits to be close to circular, similar to the planets in the solar system, but in contrast to previous measurements of more massive exoplanets where highly eccentric orbits are commonly found. These findings have important implications for planet formation theory, as well as planet occurrence rates and habitability. (Read more here: <http://arxiv.org/abs/1505.02814>.)
- Pushing the limits: K2 observations of the trans-Neptunian objects 2002 GV31 and (278361) 2007 JJ43 (Pal et al, 2015) - The paper reports on the observations of two faint outer solar system objects, highlighting the unique capability of the K2 Mission to provide unbiased rotational, shape and albedo characteristics of TNOs. (Read more here: <http://arxiv.org/abs/1504.03671>.)

Read the whole Mission Manager Update at: <http://www.nasa.gov/ames/kepler/mission-manager-update-k2-in-campaign-5>.

7. The LBTI Achieves World-Record Exo-zodi Sensitivity!



*By Rafael Millan-Gabet, NASA Exoplanet Science Institute
NASA Project Scientist*

The Large Binocular Telescope Interferometer (LBTI), P.I. Phil Hinz, University of Arizona, has made tremendous progress in instrument performance over the last year. We have demonstrated null calibration at the 500 ppm level for a bright (7 Jy) star. For the spectral type of that particular star (A3V), this translates to 8 "zodi" sensitivity, or 15 zodi if it had been a star like the Sun located at 10 pc.

Pending the recommendations of an Operational Readiness Review being held this spring, the project expects to begin the NASA exozodi survey (HOSTS, or Hunt for Observable Signatures of Terrestrial Systems) in Fall 2015 (as soon as the Summer Monsoon season ends) and to continue for a minimum of two years. At the same time, further instrument improvements will be implemented during the first year of operations, with a goal of achieving a typical sensitivity of 6 zodi for the HOSTS target list.

Meanwhile, three papers have been published by the HOSTS Science Team: on the exozodi survey target list (Weinberger et al., ApJ, 2015), on the modeling and interpretation of LBTI nulling observables (Kennedy et al., ApJ, 2015), and on the first exozodi detection by LBTI, for the well-studied object eta Corvi (Defrere et al, ApJ, 2015).

8. Science Update



*By Wes Traub, NASA Jet Propulsion Laboratory
Program Chief Scientist*

The search for life is accelerating! The science, the search, and the studies each gained ground recently.

Science. Two events stand out for me. First, at the "Life in the Universe" symposium at the Earth-Life Science Institute of the Tokyo Institute of Technology, we heard a lot about the possibilities of life on other planets, and the means for detecting it, but the talk that surprised me the most was by Nicholas Hud (Georgia Tech) who championed the idea that proto-RNA molecules could have self-assembled themselves on the exposed surface of the early Earth through the daily cycle of hydrating from a local puddle of water, solar heating, and subsequent drying out; if correct, this

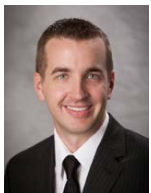
means that life could start under fairly ordinary circumstances on a suitable planet. Second, John Sutherland (University of Cambridge) finds a chemical pathway to the origin of RNA and the materials for a cell, using ingredients that were probably present on the early Earth: hydrogen cyanide (HCN), hydrogen sulfide (H₂S), and UV light, reported in <http://www.nature.com/nchem/journal/v7/n4/full/nchem.2202.html>.

Search. Radial velocity (RV) searches for nearby planets got a big boost with the announcement that NASA and the NSF are collaborating on an RV spectrometer on the WIYN telescope at Kitt Peak, through a competitive solicitation for proposals that were submitted in April. This is good news for exoplanet-seeking space missions because this spectrometer will enable a more intensive search for planets around nearby stars, both to follow-up from discoveries by the Transiting Exoplanet Survey Satellite (TESS), for example, and also to provide targets for investigation by James Webb Space Telescope (JWST) and Wide-Field Infrared Survey-Astrophysics Focused Telescope Assets (WFIRST-AFTA), for example.

Studies.

- WFIRST-AFTA, Exo-S, and Exo-C all issued final reports in January, at http://wfirst.gsfc.nasa.gov/science/sdt_public/WFIRST-AFTA_SDT_Report_150310_Final.pdf, http://exep.jpl.nasa.gov/stdt/Exo-S_Starshade_Probe_Class_Final_Report_150312_URS250118.pdf and http://exep.jpl.nasa.gov/stdt/Exo-C_Final_Report_for_Unlimited_Release_150323.pdf. The WFIRST report sets the stage for an expected Phase A start in October 2016, and the Exo-S/C reports point the way to missions that could be considered for the Decadal Review in 2020.
- NExSS, the Nexus for Exoplanet System Science, is a new added-value mechanism to foster communication among scientists who are already funded by NASA to lead the search for life on exoplanets: <http://www.nasa.gov/feature/nasa-s-nexss-coalition-to-lead-search-for-life-on-distant-worlds>, formed in April by NASA.
- There is a brand-new institute for the study of exoplanets at Cornell, inaugurated this May, led by Lisa Kaltenegger, and named the Carl Sagan Institute. See the news flash and a photo of Ann Druyan dedicating the institute at <http://www.news.cornell.edu/stories/2015/05/institute-pale-blue-dots-renamed-honor-carl-sagan>.

9. Introducing Sagan Fellow Kevin Stevenson



*By Kevin Stevenson, University of Chicago
2014 Sagan Fellow*

Planet-finding surveys have revealed thousands of confirmed exoplanets and candidates awaiting verification. Many of these objects were discovered indirectly using the transit technique, which is a powerful tool that has transformed our understanding of planetary system architecture. Furthermore, this technique has provided extraordinary insights into some of these planets' atmospheres, thus revealing unexpected discoveries and altering our perspective of these worlds.

As a Sagan Fellow, it is my goal to better understand the nature and diversity of exoplanets through atmospheric characterization. Using ground- and space-based telescopes to spectroscopically determine their atmospheric compositions, thermal structures, and chemical properties, I am pursuing answers to some of the most fundamental questions that are influencing the current trajectory of our field.

My latest research includes measuring the first spectroscopic phase curve of an exoplanet (<http://astro.uchicago.edu/~kbs/wasp43b.html>, <http://arxiv.org/abs/1410.2241>) and disproving the existence of a strong thermal inversion in the atmosphere of the exoplanet archetype HD 209458b (<http://arxiv.org/abs/1409.5336>). To learn more about my research, please visit <http://astro.uchicago.edu/~kbs/>.

10. Introducing Sagan Fellow Avi Shporer

*By Avi Shporer, Jet Propulsion Laboratory
2013 Sagan Fellow*



The high quality data available from Kepler unveils not only the variability during transit (primary eclipse) and secondary eclipse, but for the first time also the variability throughout the entire orbital phase of star-planet systems and stellar binaries. My research is focused on studying Kepler's visible-light phase curves which contain information about the companion's atmosphere and the tidal interaction between the two objects. In addition I am using orbital phase modulations to detect non-eclipsing systems. The sensitivity to non-eclipsing systems in combination with the availability of data for a large number of stars from Kepler (and K2) allows to detect intrinsically rare objects, like short period brown dwarf and white dwarf companions. A more detailed description of my work is available on my homepage: <http://web.gps.caltech.edu/~shporer/>

11. Our Search for Another Earth - Engaging the Public



*By Anya Biferno, NASA Jet Propulsion Laboratory
Program Public Engagement Specialist*

The public has been enthusiastically tuning into the hunt for exoplanets. They are fascinated with the stunning work of the community--from discovery, to characterization, to the amazing possibilities the future holds.

As we celebrate the 20th anniversary of the discovery of the first exoplanet orbiting a main sequence star, we turn our focus to the search for another Earth. In April, ExEP Public Engagement supported NASA Earth Day activities in Washington, DC. A few hundred thousand people attended these events, learning about exoplanets through a whole new lens. The Public Engagement office unveiled a brand-new interactive demonstration explaining how NASA uses transit spectroscopy to characterize exoplanets in our search for another Earth. Using diffraction grating and an "atmosphere" made from didymium glass, the public viewed a simulated transit of planet with a sodium atmosphere.

The coming months hold a bounty of opportunities for the exoplanet community to come together in celebration of the 20th anniversary of the first exoplanet discovered around a main sequence star. We would love to hear from you about any plans you may have--and would be overjoyed to partner in any events we are having, or that you may be considering. Please contact Anya Biferno at anya.a.biferno@jpl.nasa.gov for more information or with any questions. The Public Engagement office will send out an update on the plans for this anniversary soon.

12. Exoplanet Travel Bureau Posters Make a Splash!

*By Anya Biferno, NASA Jet Propulsion Laboratory
Program Public Engagement Specialist*

In January, the Exoplanet Exploration Program Office debuted three new images at the American Astronomical Society (AAS) winter meeting held in Seattle, Washington. The images were an instant hit and continue to be in high demand. They have made appearances in news outlets, TED talks, exhibit areas, television shows, and across all social media platforms.

The Program Office is proud to acknowledge the creators of these images, Joseph Harris, David Delgado, and Dan Goods, resident artists at the Jet Propulsion Laboratory. Three new poster concepts are in the works, so stay tuned!

You can download these images for print by visiting the Exoplanet Travel Bureau website here: <http://planetquest.jpl.nasa.gov/exoplanettravelbureau>



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